Astrophysical Journal 2010 vol.714 N1, pages 178-193

The double-degenerate nucleus of the planetary nebula TS01: A close binary evolution showcase

Tovmassian G., Yungelson L., Rauch T., Suleimanov V., Napiwotzki R., Stasińska G., Tomsick J., Wilms J., Morisset C., Pẽa M., Richer M.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

We present a detailed investigation of SBS1150+599A, a close binary star hosted by the planetary nebula PNG135.9+55.9 (TS 01). The nebula, located in the Galactic halo, is the most oxygen-poor known to date and is the only one known to harbor a double degenerate core. We present XMM-Newton observations of this object, which allowed the detection of the previously invisible component of the binary core, whose existence was inferred so far only from radial velocity (RV) and photometric variations. The parameters of the binary system were deduced from a wealth of information via three independent routes using the spectral energy distribution (from the infrared to X-rays), the light and RV curves, and a detailed model atmosphere fitting of the stellar absorption features of the optical/UV component. We find that the cool component must have a mass of 0.54 ± 0.2 M ⊙, an average effective temperature, T eff, of 58,000 ± 3000K, a mean radius of 0.43 ± 0.3R ⊙, a gravity, log g = 5.0 ± 0.3, and that it nearly fills its Roche lobe. Its surface elemental abundances are found to be: 12 + log He/H = 10.950.04dex, 12 + log C/H = 7.20 0.3dex, 12 + log N/H < 6.92, and 12 + log O/H < 6.80, in overall agreement with the chemical composition of the planetary nebula. The hot component has T eff = 160-180kK, a luminosity of about 104 L ⊙ and a radius slightly larger than that of a white dwarf. It is probably bloated and heated as a result of intense accretion and nuclear burning on its surface in the past. The total mass of the binary system is very close to the Chandrasekhar limit. This makes TS01 one of the best Type Ia supernova progenitor candidates. We propose two possible scenarios for the evolution of the system up to its present stage.

http://dx.doi.org/10.1088/0004-637X/714/1/178

Keywords

Binaries: close, Stars: AGB and post-AGB, Stars: atmospheres, Stars: evolution